Small Business Innovation Research/Small Business Tech Transfer

Turbulence Modeling and Risk-Based Planning to Enable Safe Autonomous Operations, Phase I

Completed Technology Project (2018 - 2019)

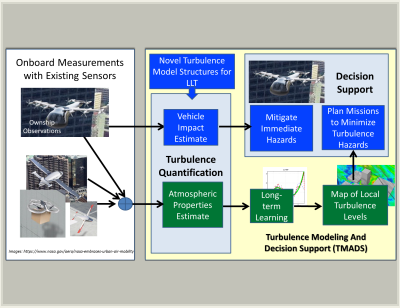
Project Introduction

Aircraft routinely encounter turbulence, and appropriate responses to this turbulence are critical to maintain safe aircraft operation within prescribed operating limits and to effectively accomplish missions. Current airspace operations rely primarily on onboard human pilots to assess the severity of turbulence and respond appropriately. The future air transportation system will have increasing levels of autonomy, and many operations will be conducted without a skilled human operator onboard. Automated systems are thus needed to assess how turbulence is impacting an air vehicle and to respond appropriately. Future airspace operations will also occur in different environments. In particular, dramatically expanded low-altitude operations, including operations in urban environments, will occur as concepts such as those for Urban Air Mobility (UAM) become a reality. Much of the effort that has been devoted to turbulence monitoring and forecasting in the past has targeted commercial transport operations, especially high-altitude cruise conditions. Turbulence in the urban canyon is driven by different physical processes, and it has different characteristics than high-altitude turbulence. New models of turbulence need to be developed to support prediction of turbulence in low-altitude environments, including the urban canyon, and to perform onboard turbulence identification. The proposed work will develop the Turbulence Modeling and Decision Support System for UAS, with a focus on very low altitude operations by future air vehicles. It will include development of new model structures that capture the characteristics of turbulence in the urban boundary layer, the roughness sub layer, and the urban canopy layer. It will include development of onboard approaches to identify turbulence levels, methods to predict turbulence, and decision making tools for both short term responses to turbulence and mission planning based on turbulence predictions.

Anticipated Benefits

The proposed technology will help to enable increasingly autonomous operations, directly supporting the goals of the UAS Integration in the NAS project started by ARMD in 2011, and the UAS Traffic Management (UTM) project begun in 2015. The proposed work will also support NASA's emerging interest in Urban Air Mobility, enhancing safety for both manned and unmanned vehicles, and benefitting passenger comfort in vehicles such as air taxis.

The proposed technology will be an important enabler of increasingly autonomous SUAS operations, such as BVLOS inspection and package delivery by commercial operators, reconnaissance operations by the military and border patrol, and disaster response by government and commercial entities. The proposed technology will benefit other future vehicles that operate with a high level of automation or autonomy, especially vehicles such as air taxis that will operate at low altitudes in urban areas.



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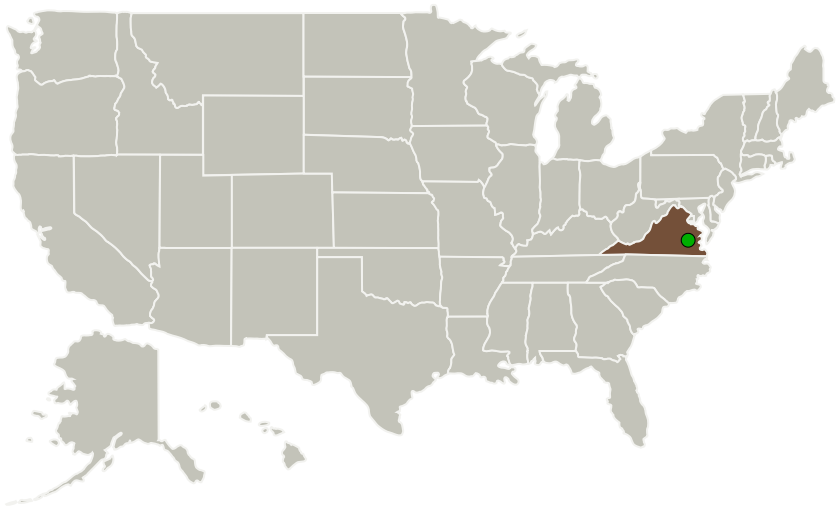
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Barron Associates, Inc.	Lead Organization	Industry	Charlottesville, Virginia
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations
Virginia

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137365)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Barron Associates, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Richard Adams

Co-Investigator:

Alec Bateman

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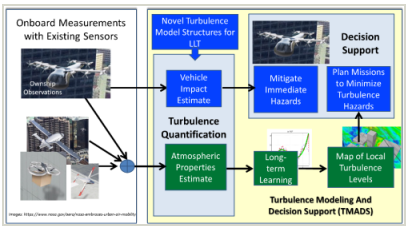
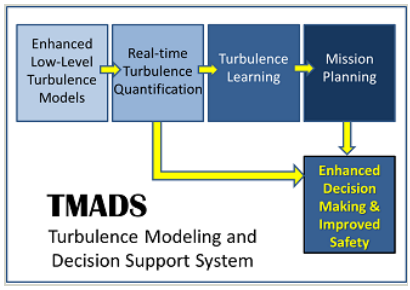
Images



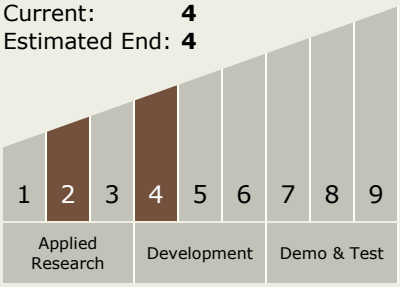
Briefing Chart Image
Turbulence Modeling and Risk-Based Planning to Enable Safe Autonomous Operations, Phase I *(https://techport.nasa.gov/image/135576)*



Final Summary Chart Image
Turbulence Modeling and Risk-Based Planning to Enable Safe Autonomous Operations, Phase I *(https://techport.nasa.gov/image/128209)*

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.3 Aero Propulsion
    - TX01.3.1 Integrated Systems and Ancillary Technologies

Target Destination

Earth